Plant and plant/microbe traits impacting N_2O emissions from soil

Keywords: HME, Lipids, Nitrogen, Nitrous oxide, nitrification

Brief project outline:

Project Background

Plants have the ability to modify nitrogen cycling processes in soils and affect nitrous oxide (N_2O) production, a potent greenhouse gas, however, it remains unknown which plant traits are responsible for driving these changes. This represents a key barrier for developing N_2O emission mitigation strategies despite many years of, largely, soil focussed research. Therefore, a wider assessment of plant/microbe interactions and N_2O is now required.

Scientists at AgResearch have recently identified a perennial ryegrass, genetically modified (GM) for higher lipids, which unexpectedly displayed a ~40-50% reduction in N_2O emissions from the soil compared to the control plants. Termed 'High Metabolisable Energy' (HME) ryegrass, the GM status of this technology impedes its immediate deployment as an emissions reduction tool in NZ. However, it does provide the perfect opportunity to identify those specific plant and plant/microbe traits which are responsible for the reduction of N_2O emissions from soil. In the short-term, this could be used to develop new grazing practices to induce N_2O-mitigation traits in conventional ryegrass varieties and in the longer term, improve future forage breeding efforts targeting environmentally friendly high productive forage cultivars. This project will be funded through the HME ryegrass development program funded by the AgResearch Strategic Science Investment Fund (SSIF).

PhD Program

Objective 1: Identification of plant-level N_2O mitigation traits via morphological, biochemical, physiological and plant microbe interactions by comparison of low-N_2O HME ryegrass to high-N_2O controls. Primary observations are to include plant dry matter production, carbon assimilation and allocation, N partitioning, root exudate properties and plant/microbe traits such as rhizosphere nitrifier and denitrifier community diversity and richness.

***Objective 2: Testing plant-level N_2O mitigation traits*.** Direct assessment of those traits identified in Objective 1 will be made using a variety of techniques such as editing for single gene knockouts or over-expressors / isolation, synthesis of root exudates, changes in sink: source balance via grazing management.

Objective 3: Screening forage germplasm for N_2O mitigation potential. The identified traits will be used to screen ryegrass cultivars and other species for their potential to reduce N_2O emissions.

Preferred candidate skills or experience:

- **Meet PhD entry requirement at Massey university.**
  See: Entry requirement Massey University
- Experience growing, maintaining, and experimenting on plants, especially perennial ryegrass or other forages
- Fundamental knowledge of soil science, plant biochemistry and physiology
- Statistical analysis

Host institute(s) and location(s): AgResearch Limited, Grasslands Research Centre, Palmerston North

Project Team: Saman Bowatte (Climate Change Impacts & Adaptation Team); Paul Newton (Climate Change Impacts & Adaptation Team); Luke Cooney (Plant Biotechnology Team); Nick Roberts (Plant Biotechnology Team)